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case also, $R = F$. But for the same track and train, F may be considered constant; therefore R is constant, that is, a brake is equally effective whether applied at the top or side of a wheel.

But our correspondent has proved, by experiment, that a force of two pounds at A , in the direction AE , is held in equilibrium by a force of one pound at G in the direction GH ; of two pounds at I , in the direction IK , and of about four pounds at R , in the direction RL ; whence he concludes that the effect of the brake to arrest the motion of the train must depend on its position relative to the point of contact between the wheel and rail.

In the first of the experiments above named we have a lever of the second order; resistance at G , power at A , and fulcrum at F ; the experiment therefore does not apply to the case under consideration, for no amount of pressure at G can prevent a force at A , in the direction AE , from producing rotation about the point F .

In the second experiment we have a lever of the first order, fulcrum at A ; consequently if the weight of the wheel and the power at I are sufficient to develop two pounds of friction at F , the forces will be in equilibrium as shown by the experiment, but not otherwise.

In the third experiment, we must again regard F as the fulcrum, and consequently the lever will be of the first order; therefore, when the forces at A and R are in equilibrium they must have the proportion of FL to FA .

An analysis of the experiments therefore shows, that the *first* is not applicable; that the *second* confirms Eq. (1) for the point I , and that the *third* proves, what is otherwise apparent, that a brake applied at F would be useless if applied to prevent rotation about the point F . It is apparent, however, that if rotation about A is prevented, no rotation about F can occur, and hence the brake is only used to prevent rotation about A ; and for that purpose, it has been shown, its position, with respect to the point F , is immaterial.

A QUESTION AND ITS SOLUTION.

BY GEORGE EASTWOOD, SAXONVILLE, MASS.

QUESTION.—When only the four sides of a quadrangle are given, how may it be known that the figure can be circumscribed by a circle?

SOLUTION.—Let $ABCD$ be a quadrangle whose sides AB, BC, CD, DA , are known by measurement. Produce the opposite sides AB, DC , to meet in the point E , and the opposite sides DA, CB , to meet in the point F .

Draw EH and FI to bisect the angles E and F , and let O be the point of their intersection. Draw, also, the diagonals AC , BD . Then, evidently, we have

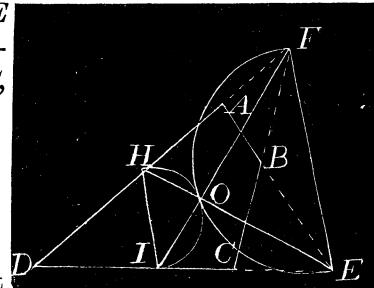
$$\begin{aligned}\angle ABC &= BFO + FOE + OEB \\ &= \frac{1}{2}\angle F + FOE + \frac{1}{2}\angle E,\end{aligned}$$

$$\begin{aligned}\angle ADC &= OIC - \frac{1}{2}\angle F \\ &= FOE - \frac{1}{2}\angle E - \frac{1}{2}\angle F\end{aligned}$$

$$\therefore \angle ABC + \angle ADC = 2FOE = \text{two right}$$

angles when FOE is a right angle, and the points A , B , C , D will be on the circumference of a circle. Hence this criterion:—

Prolong the opposite sides AB , DC and DA , CB to meet in E and F . Draw the bisectors EH , FI , and join IH , EF , upon which describe semicircles. Then, if these semicircles touch each other in the point of intersection (O) of the bisectors, FO will be perpendicular to EO , angles $A+B$ will = angles $B+D$, and the quadrangle can be circumscribed by a circle.



ON THE ROOTS OF EQUATIONS.

BY PROFESSOR WORPITZKY, BERLIN, PRUSSIA.*

SUPPOSE a portion of an area z to be ascertained which contains a single root of the equation $f(z) = 0$; the root itself $z = c$ being unknown.

Moreover, the function, $f(z)$, is supposed to be monogen in all parts of the area; finally determined; and with the exception of $z = c$ to be nowhere equal to zero.

Then $f(z) = (z - c)\varphi(z)$ may be substituted, in which equation the function, $\varphi(z)$, possesses exactly the same attributes, except that $\varphi(z) = C$; that is a finite value different from c : and after the well known formula of *Lauch* concerning marginal integrals we obtain

$$\frac{2\pi i}{C} = \int \frac{dz}{f(z)}.$$

Hence C may be ascertained without knowing the value of c .

On the other hand;

$$\begin{aligned}f'(z) &= \varphi(z) + (z - c)\varphi'(z); \\ f'(c) &= \varphi(c) = C.\end{aligned}$$

*As this paper from Prof. Worpitzky, in German, was accompanied by a letter to Alex. Evans, Esq., of Elkton, Md., referring to his translation at p. 66, Vol. IV, *ANALYST*, the original was sent by us to Mr. Evans, to whom we are indebted for this translation.—Ed.